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ИССЛЕДОВАНИЕ РАЗРУШЕНИЯ И ПЛАСТИЧНОСТИ ПРИ ЛОКАЛЬНОМ НАГРУЖЕНИИ МНОГОСЛОЙНЫХ КОМПОЗИЦИОННЫХ СОЕДИНЕНИЙ, СОСТОЯЩИХ ИЗ АМОРФНО-НАНОКРИСТАЛЛИЧЕСКИХ ПЛЕНОК И ПОЛИМЕРА

Экспериментально исследованы закономерности деформирования и разрушения двухслойных композиционных соединений: пленка — полимер — пленка — полимер. Установлена специфика изменения закономерностей разрушения композита в случае легирования полимерной подложки углеродными нанотрубками. Экспериментально установлен характер изменения микротвердости композита от нагрузки на индентор.

Ключевые слова: механические испытания, нанокристаллические пленки, двухслойные композиционные соединения.

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STUDY OF FRACTURE AND PLASTICITY UNDER LOCAL LOADING OF MULTILAYER COMPOSITE COMPOUNDS CONSISTING OF AMORPHOUS NANOCRYSTALLINE FILMS AND POLYMERS

The regularities of deformation and destruction of two-layer composite compounds film-polymer-film-polymer are experimentally investigated. The specificity of destruction in the case of a doped substrate with carbon nanotubes is established. The nature of the changes in the microhardness of the composite from the load on the indenter is experimentally established.

Key words: mechanical testing, nanocrystalline films, two-layer composite compounds.

The aim of this work is to develop a new method of mechanical testing of the surface of multilayer composites.

The size of samples was 15×25 mm. They were made from a thin amorphous-nanocrystalline band $Co_{71,66}B_{4,73}Fe_{3,38}Cr_{3,14}Si_{17,09}$. The two layer composites were prepared: nanocrystalline film — polymer compound — second nanocrystalline film — thick polymer compound.

The first series of samples were prepared from amorphous-crystalline samples and polymer composites. The second series of samples were prepared from amorphous-crystalline samples and polymer composites saturated by carbon nanotubes.

The character of alternation of microhardness and formation patterns of the destruction of the two-layer composite solid compounds amorphous-nanocrystalline film of the base polymer was experimentally determined.

It is shown that as the load is increased, microhardness is also increased. Further increasing of load will decrease the microhardness and subsequently its stabilization. The complex nature of the microhardness change is explained by the influence of the substrate and the second nanocrystalline film.

At low loads (1–1,5 N), microhardness is determined by the influence of a thin and solid nanocrystalline film. The usage of a standard mechanical test (loads up to 0,5–1 N), allows us to measure the microhardness of the nanocrystalline film.

At loads of more than 1,5 N, it is correct to talk about measuring the microhardness of the composite: first film, substrate and second nanocrystalline film. In the case of increasing the load up to a value of more than 1,5–2 N, it is correct to talk about the measurement of the microhardness of the composite compound as a whole, with the dominant role of the substrate.

Experimentally investigated the nature of the microfractures of the composite under a local loading (loading from 1,5 to 3 N). It is shown that micro-pictures of destruction differ significantly from the micro — picture of destruction formed on a single-layer composite.

As a result, the known formula from literature for determining microhardness of single-layer coatings cannot be used for calculating the one for the case of two-layer composite compounds [1].

Mechanical tests were carried out on the composite compounds of thin nanostructured coatings — polymer base reinforced with carbon nanotubes. The regularities of deformation and destruction were determined. It was shown that carbon nanotubes reduce the microhardness and plasticity of the material, which is explained by their uneven distribution and the formation of gas-saturated conglomerates. Morphological features of macroscopic fractures of composite compounds of the crystal film — substrate composite are similar for the two types of substrates: alloyed and not alloyed with carbon nanotubes.

Литература

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